M/019/005

SPILL PREVENTION AND STORMWATER CONTROL PLAN

MOAB SALT, INC.

MOAB, UTAH

NEXT CERTIFICATION DATE: ______________________

This Plan is a compilation of the facility's Spill Prevention Control and Countermeasures Plan (SPCC) and the facility's Stormwater Pollution Prevention Plan (SW3P).

CERTIFICATION

I Eric K. York, a Registered Professional Engineer, certify that I have reviewed the attached Spill Prevention and Stormwater Control Plan for the Moab Salt, Inc. facility located in Moab, Utah. I am familiar with the regulations contained in 40 C.F.R. 112 et seq. and Permit No. UTR 61000 issued by the Utah Department of Environmental Quality and with the terms of the facility's Stormwater Permit. I hereby certify that the attached plan has been prepared in accordance with good engineering practices. This the 2nd day of October, 1993.

Eric K. York
Registered Professional Engineer

ERIC K. YORK # 6692

Seal

This Plan must be reviewed and recertified whenever there is a change in facility design, construction, operation or maintenance which materially affects the facility's potential for spills or stormwater contamination.

Additionally, this Plan must be reviewed and recertified every three years. If during this review, it is determined that (1) there exists spill or stormwater control technology which would "significantly reduce the likelihood of a spill or stormwater contamination at the facility" and (2) this additional technology has been "field proven" to be more effective than the existing technology utilized at the facility, then the Plan should be amended to incorporate this technology.

Within six months after each review the Plan shall be amended to incorporate any changes warranted by the review.

REGISTERED PROFESSIONAL ENGINEER
ERIC K. YORK
6692
STATE OF UTAH

NEXT CERTIFICATION DATE:

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NOTE: This Certification must be updated every three (3) years or, as noted above, after any operational change materially affecting the potential for spills at the facility.

TABLE OF CONTENTS

-PLAN IS A LARGE VOLUME

1. Personnel Responsible for Plan Implementation

2. Sources of Potential Environmental Impact

   a. Site Drainage
      (1) Site Map
      (2) Drainage Map
   b. Material Inventory
   c. Spill and Leak History (prior 3 years) (refer to spill report)
   d. Stormwater Discharge Monitoring
   e. Process Activities
      (1) receipt of raw materials
      (2) loading of products
      (3) storage areas
         (i) raw materials
         (ii) product
         (iii) maintenance items
         (iv) waste materials
      (4) production areas
      (5) pollution control devices (scrubbers, etc.)
      (6) drainage
      (7) disposal areas

3. Best Management Practices

   a. housekeeping
   b. preventive maintenance
   c. sediment and erosion control
   d. stormwater runoff management
   e. spill minimization procedures
   f. spill response procedures
   g. spill reporting procedures
   h. inspections
   i. training
   j. record keeping

4. Annual Compliance Evaluation and Report

5. Appendices

Appendix A - Oil Pollution Prevention Regulations (40 C.F.R. Part 112)
Appendix B - State of Utah Permit No. UTR610000
Appendix C - Material Safety Data Sheet

<u>INTRODUCTION</u>

The purpose of this Plan is to lessen the likelihood of a spill or stormwater contamination at the facility. This may best be accomplished by following the guidelines set forth in this Plan <u>and</u> by the constant attention of every employee to areas of potential risk.

This Plan will be reviewed and amended as set forth herein. Responsibility for compliance with the provisions of the Plan shall be the responsibility of the facility's Manager of Operations or his designated representative.

NEXT CERTIFICATION DATE:

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M/019/005

POTENTIAL FOR BRINE SEEPAGE ALONG ROCK FRACTURES, BRINE LAKE STORAGE AREA, CANE CREEK MINE, GRAND COUNTY, UTAH

MOAB SALT, INCORPORATED
MOAB, UTAH

Prepared by

EARTHFAX ENGINEERING, INC.
SALT LAKE CITY, UTAH

JUNE 26, 1989

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1
2.0	METHODS OF DATA COLLECTION	4
2.1	SURFICIAL GEOLOGY	4
2.2	VLF-EM	4
3.0	RESULTS AND DISCUSSION	9
3.1	RESULTS OF BRINE SEEP SURVEY	9
3.2	VLF-EM	12
3.3	DISCUSSION	22
4.0	REFERENCES	24

LIST OF FIGURES

		Page
Figure 1.	General Location of the Cane Creek Mine	2
Figure 2.	Map of Brine Lake and Surrounding Area	3
Figure 3.	Map Showing Faults Which Intercept the Brine Lake Area	5
Figure 4.	Map Showing Locations of VLF-EM Lines	6
Figure 5.	Southeast View of Brine Seepage in Canyon North of Brine Lake	10
Figure 6.	Northwest View of Brine Seepage in Canyon North of Brine Lake	10
Figure 7.	Northwest View of Fault C in Canyon North of Brine Lake	11

TABLE OF CONTENTS (Continued)

Figure 8. Southeast View of Brine Seepage Associated with Fault B at the South Abutment of the Brine Lake Dam . . . 11

Figure 9. Northwest View of Brine Seepage Associated with Fault B at the South Abutment of the Brine Lake Dam . . . 13

Figure 10. North View of Brine Seepage Away From Fault B Below Brine Lake Dam 13

Figure 11. East View of Arroyo Below Brine Lake Dam 14

Figure 12. VLF-EM Profile of Line 1 15

Figure 13. VLF-EM Profile of Line 2 16

Figure 14. VLF-EM Profile of Line 3 17

Figure 15. VLF-EM Profile of Line 4 18

Figure 15. VLF-EM Profile of Line 4 (Continued) 19

POTENTIAL FOR BRINE SEEPAGE ALONG ROCK FRACTURES, BRINE LAKE STORAGE AREA, CANE CREEK MINE, GRAND COUNTY, UTAH

1.0 INTRODUCTION

This report presents results of a surficial geologic field investigation and a very-low-frequency electromagnetic (VLF-EM) survey of bedrock fractures at the Cane Creek Mine, Grand County, Utah (Figure 1). The emphasis of this report is directed toward a study of fractures which underlie Moab Salt's brine storage lake and those fractures associated with the brine lake dam abutments and spillway (Figure 2). This study was undertaken in response to written comments prepared (1/28/88) by the Utah Division of Oil, Gas and Mining (DOGM) concerning the potential of fractures which underlie the brine lake to transmit brine to off-site areas. Moab Salt, in written response (5/18/88) to DOGM comments, agreed to undertake additional study of faulted and fractured bedrock in the vicinity of the brine lake area to evaluate the potential for brine seepage toward the Colorado River.

This report is divided into four sections including this introduction. Sections 2 presents methods of data collection; whereas, Section 3 presents results and discussion of the investigation. Referenced literature is documented in Section 4.

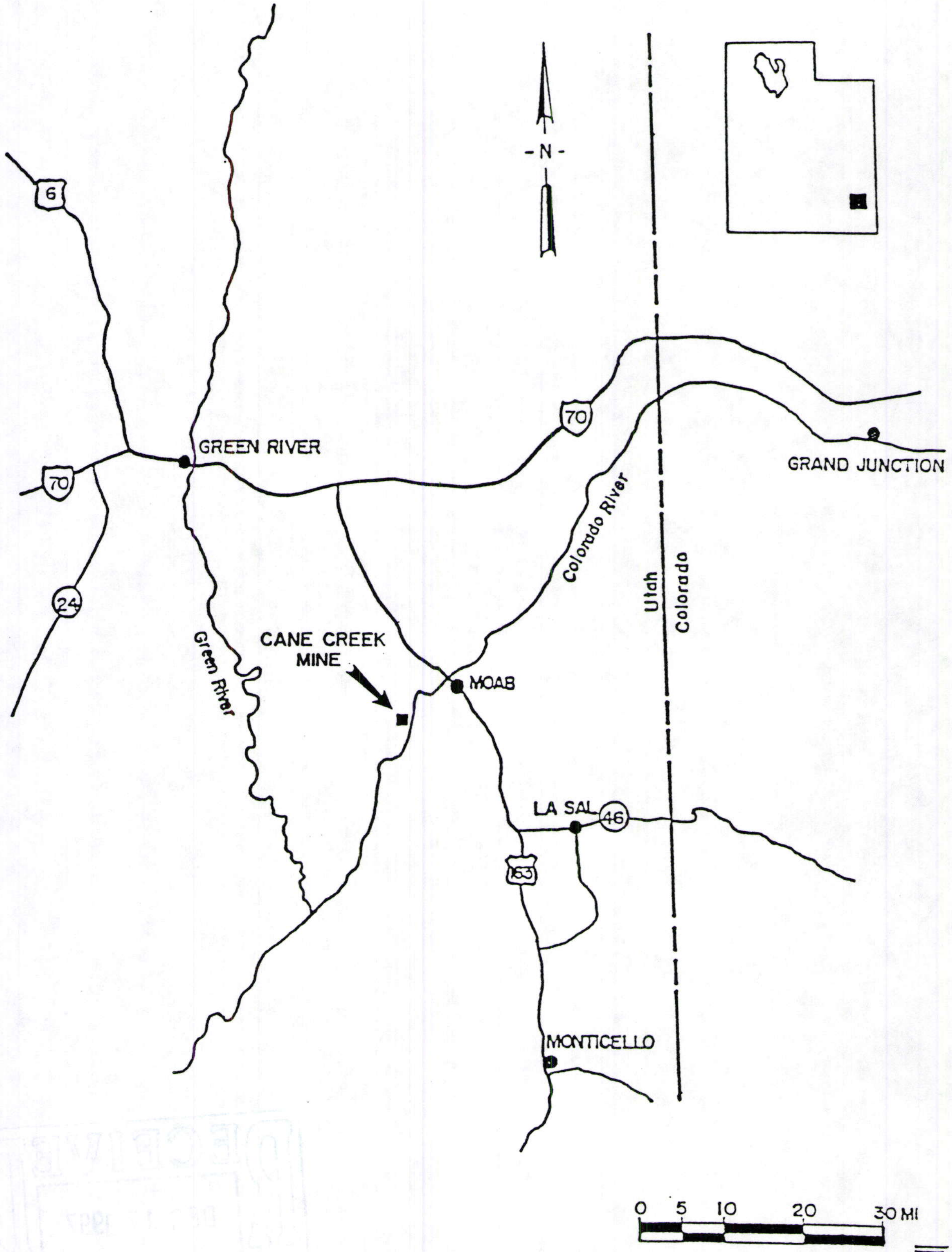

Figure 1. General Location of the Cane Creek Mine.

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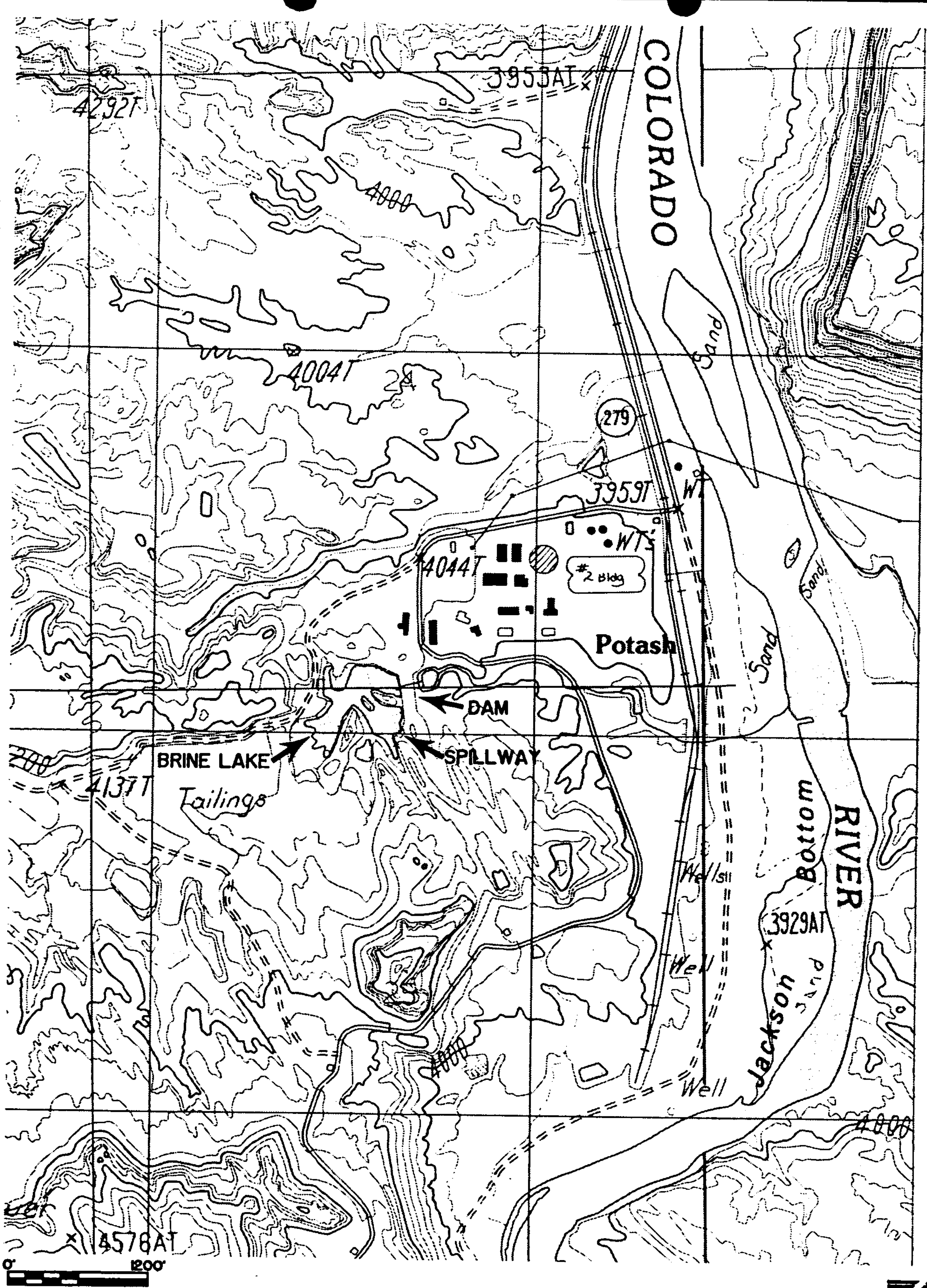

BASE MAP FROM USGS GOLD BAR CANYON
7.5 MINUTE SERIES 1985

Figure 2. Map of Brine Lake and Surrounding Area.

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2.0 METHODS OF DATA COLLECTION

2.1 SURFICIAL GEOLOGY

In late December 1988, EarthFax Engineering reviewed available geologic data pertaining to faults and fractures in the vicinity of the brine lake and salt storage area (Huntoon, 1985). Locations and orientations of faults were verified by means of vertical aerial photographs with stereoscopic coverage (frames 42 and 43 of mission UPRM-57A; approximate scale 1:20,000) purchased from the USGS EROS Data Center, Sioux Falls, South Dakota. Faults which show obvious surface displacement are shown in Figure 3. Relative displacements and amounts of offset along the faults are taken from Huntoon (1985). During late February 1989, EarthFax Engineering conducted a ground reconnaissance of the faults and fractures to detect evidence of surface seepage of brine. Results of the ground reconnaissance are presented in Section 3.1.

2.2 VLF-EM

Four VLF-EM traverses were conducted at locations shown in Figure 4. VLF-EM lines 1 and 2 are located southeast of faults C and D as mapped on Figure 4. These lines were positioned (1) to avoid masking of EM readings from thick sequences of potentially conductive overburden which lies along the flood plane of the Colorado River (see Figure 2, Huntoon, 1985, map units QTu and Qu), (2) to avoid topographic influences on the EM readings due to rugged topography which lies to the northwest along the access road to the pumping stations, (3) to avoid EM interferences due to power lines, steel pipe lines of the injection/extraction system, railroad tracks, and buried metal waste along the west side of the rail car storage area, and (4) to provide VLF-EM coverage at the lowest possible elevation in relation to the water table. Stations were spaced every 100 feet along lines 1 and 2.

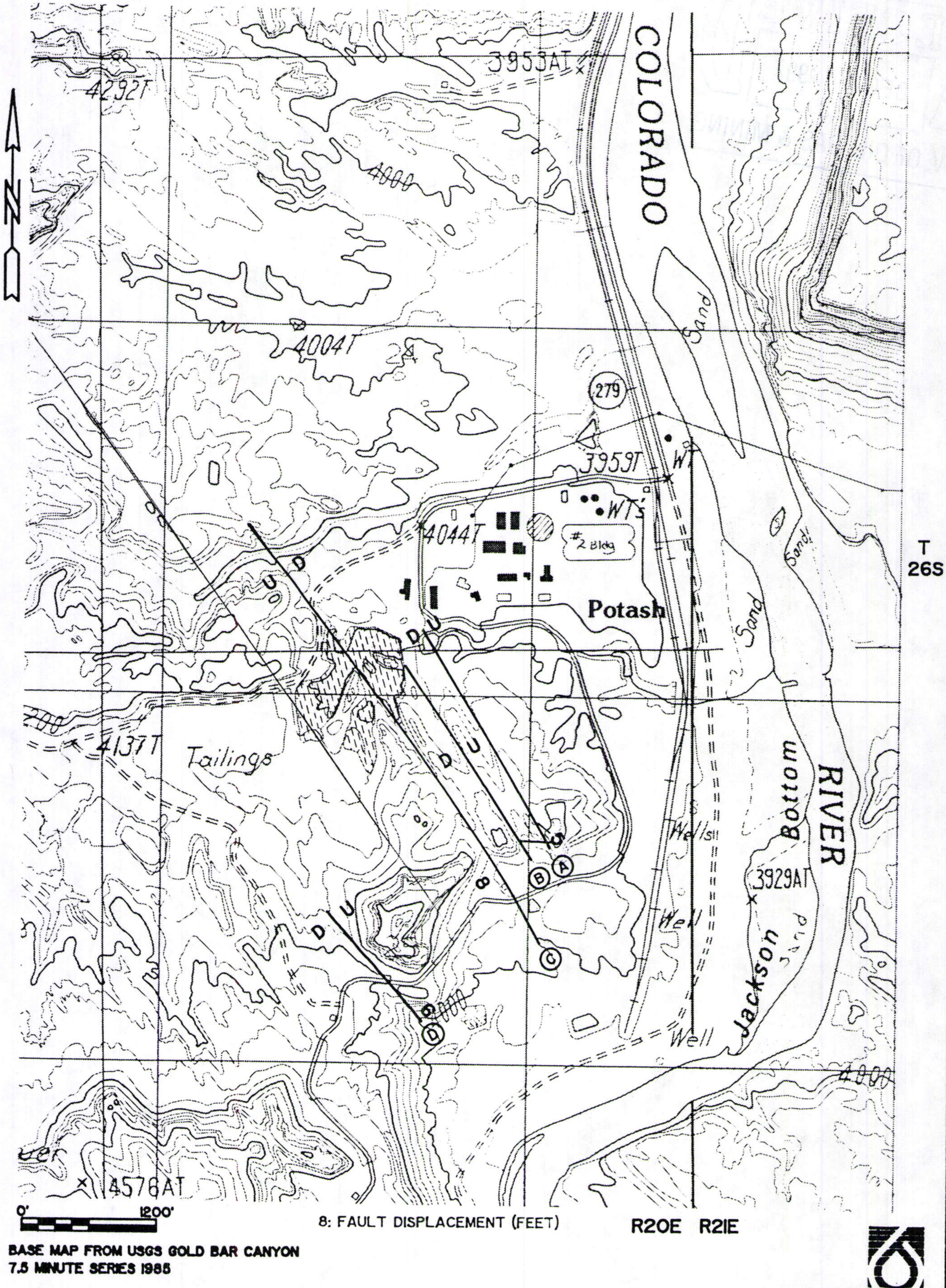

Figure 3. Map Showing Faults Which Intercept the Brine Lake Area.

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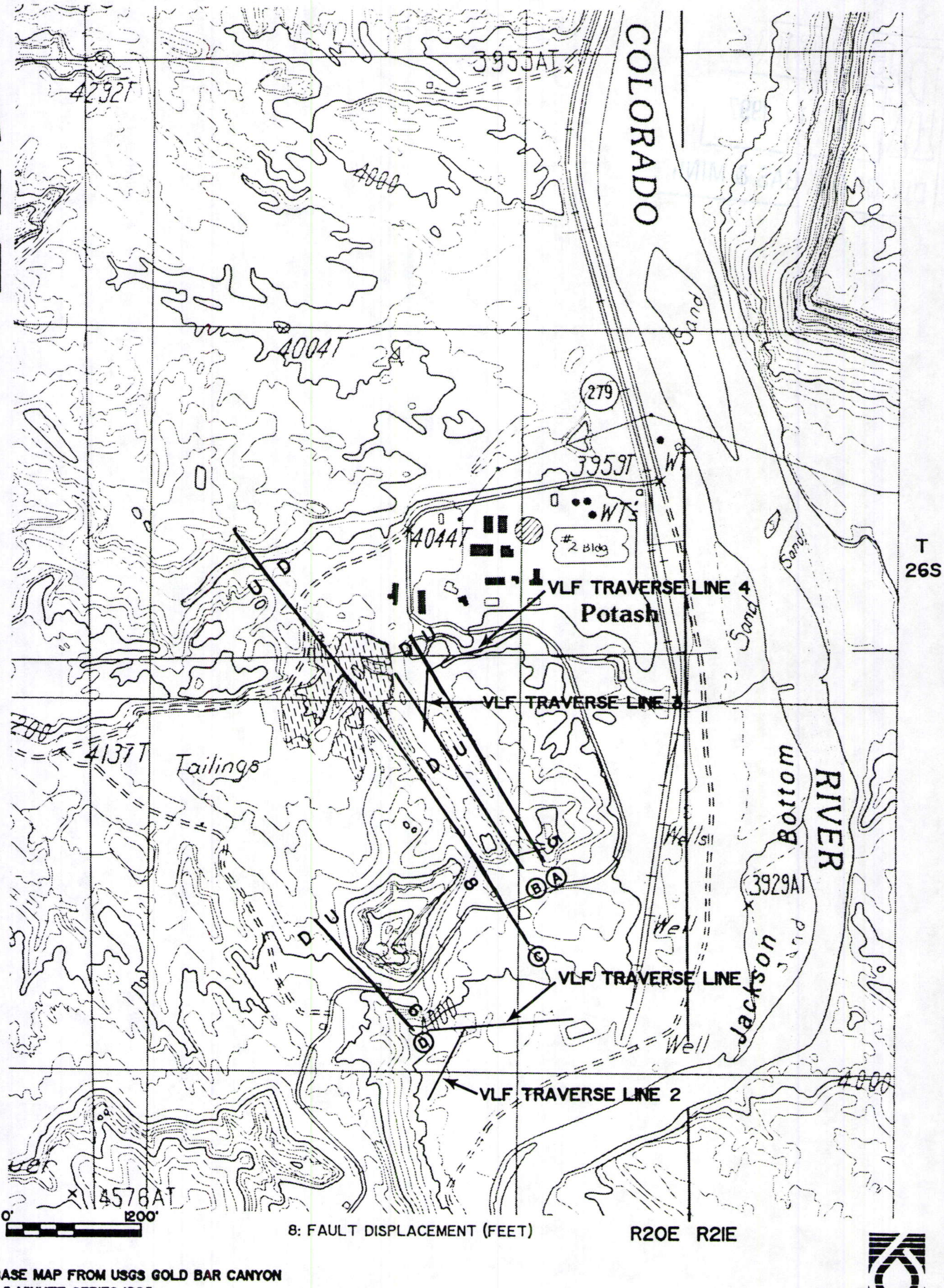

Figure 4. Map Showing Locations of VLF-EM Lines.

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Lines 3 and 4 were positioned northward along the toe of the dam and along the arroyo which extends eastward from the toe of the dam, respectively. Each line was centered along gentle, continuous slopes between larger topographic features. These lines primarily traverse bedrock with little or no overlying soil horizons. Stations were spaced on 25-foot intervals. Line 4 was terminated at the intersection of the arroyo with surface power lines and steel pipes which lie along the main access road.

VLF field measurements were made by means of a Crone Radem VLF-EM receiver tuned to the Seattle, Washington VLF communications station (24.8 KHz). Measurements at each station included the total horizontal field strength of the magnetic component of the VLF field (amplitude of the major axis of the polarization ellipse) and the tilt angle of the magnetic field component from the horizontal (degrees). The field strength was measured as a percent of normal field strength established at a base station. The field strength was checked at the base station before and after each line was complete. As a consequence, these data were corrected for drift in field strength, if detected. All measurements were made as recommended by the manufacturer of the VLF-EM receiver (Crone Geophysics Limited, Mississauga, Ontario, Canada). Reviews of the basic principles of VLF theory and interpretation are presented by Paal (1965), Paterson and Ronka (1971), and Phillips and Richards (1975), among others.

To evaluate the effects of topography along lines 1 and 2, the methodology of Whittles (1969) was used. This amounted to determining the rate of change of the tilt angle profile, or first derivative of the tilt angle profile. The first derivative method is similar to the method presented by Fraser (1969); both methods act as pass-band filters to more clearly define anomalous areas. According to Whittles (1969), the first derivative of the tilt angle profile is often more diagnostic than the simple "cross over" type of interpretation because it more clearly outlines zones of high conductivity without much interference from topography. As a "rule of thumb," changes in the first derivative of the tilt angle profile which are greater than 0.1 degrees per foot generally are more than can be explained by topography alone when surveying low-level anomalies (Whittles, 1969). Because lines 3 and 4 traverse gentle topographic profiles of nearly constant slope, it was not necessary to derive first derivatives of the tilt angle profile for these two lines. Topographic profiles along lines 1 and 2 were measured between survey stations by means of an Abney level and two staffs, each five feet long. Station locations on all lines were placed along each line by means of a 300-foot fiberglass tape.

3.0 RESULTS AND DISCUSSION

3.1 RESULTS OF BRINE SEEP SURVEY

Figures 5 through 7 show evidence of recent and current brine seepage along the intersection of fault C (see Figure 3) and the small canyon which lies northwest of the brine lake.

Figure 5 shows fractures associated with fault C as they are exposed in the southeast wall of the canyon. Note salt precipitation on sandstone outcrops and associated dead vegetation. Soils in foreground of Figure 5 were damp from seepage during late February 1989. Figure 6 shows active brine seepage toward the ephemeral stream bottom of the canyon (view is to the northwest). Note that outcrop surfaces are wet and that the salt encrustation in the middle ground is approximately 3 to 5 inches thick. Similar salt encrustation is present on outcrop surfaces adjacent to the area shown in Figure 6. Figure 7 shows the continuation of fault C into the northwest side of the canyon. Soils and outcrop surfaces in the foreground are wet due to seepage; note salt encrustation on the right side of the small graben structure. Brine seepage is also evidenced by salt efflorescence at the intersection of the ephemeral stream channel and fault C (middle ground of Figure 7). Spring runoff transmitted through the alluvial materials in the canyon bottom was just below the ground surface at the time of the survey. Brine seepage from fault C in the canyon area probably contributes dissolved solids to underflow (subsurface runoff) in the stream channel.

Upstream stretches of the canyon were also surveyed for additional brine seeps issuing northwest of the brine lake. Although minor amounts of salt efflorescence were noted on outcrop surfaces within the ephemeral stream channel, evidence was lacking for significant amounts of brine seepage along the canyon walls or in the stream bottom.

Figure 5. Southeast View of Brine Seepage in Canyon North of Brine Lake.

Figure 6. Northwest View of Brine Seepage in Canyon North of Brine Lake.

Figure 7. Northwest View of Fault C in Canyon North of Brine Lake.

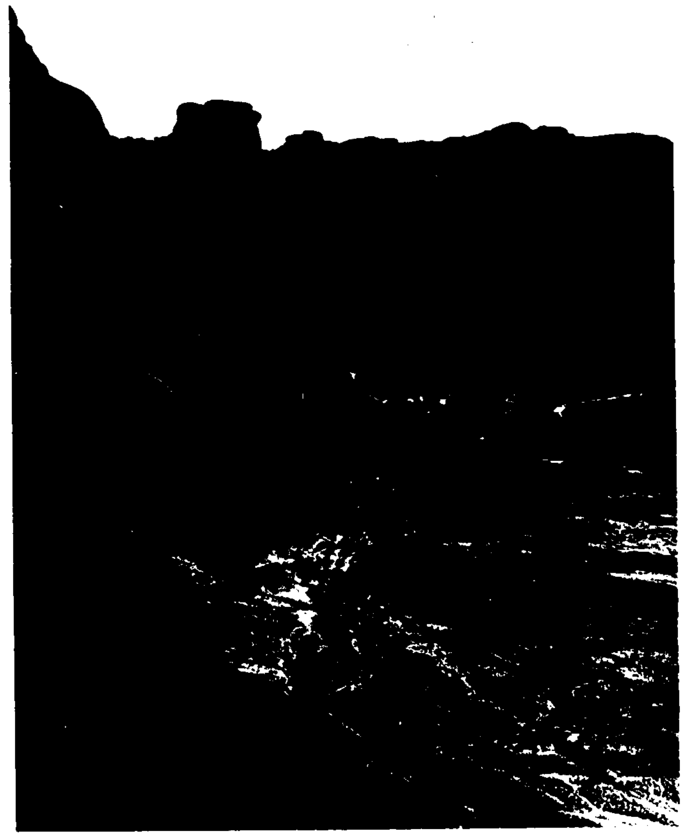

Figure 8. Southeast View of Brine Seepage Associated with Fault B at the South Abutment of the Brine Lake Dam.

Figures 8 through 10 show brine seepage southeast of the brine lake spillway and below the south abutment of the brine lake dam.

Figures 8 and 9 show brine seepage from joints which intercept the south dam abutment. These fractures are associated with fault B shown in Figure 3. Rivulet patterns shown in the middle ground of Figure 8 indicate that seepage primarily is derived from the first two joints which lie west of fault B (view is to the southeast). Figure 9 shows the position of the lake spillway (left background) and the south abutment of the dam (right background). Note that the lower portions of the fill material below the spillway and south abutment are brine saturated. Figure 10 shows northward movement of the brine seepage away from fault B toward the plant (the head frame above shaft No. 1 is shown in the right background). Surface evidence suggests that the brine seepage moves only 75 to 100 feet northward (across the strike of the fractures) before migrating downward into other fractures or evaporating to the atmosphere. Evidence of surface runoff of brine from fractures below the dam was not detected within the arroyo below the dam (see Figure 11).

Ground reconnaissance for evidence of brine seeps was conducted along the canyon slopes above the Colorado River and near the southwestern extent of faults A, B, C, and D as mapped in Figure 3. Evidence of active seepage was not detected. Only a minor amount of efflorescence was observed near the southeastern termination of fault D. This efflorescence is present near station 13+00 at the western termination of VLF line 1 (Figure 4).

3.2 VLF-EM

Geophysical data obtained along VLF-EM lines 1 through 4 are shown in Figures 12 through 15, respectively. Locations of the lines are shown in plan view in Figure 4.

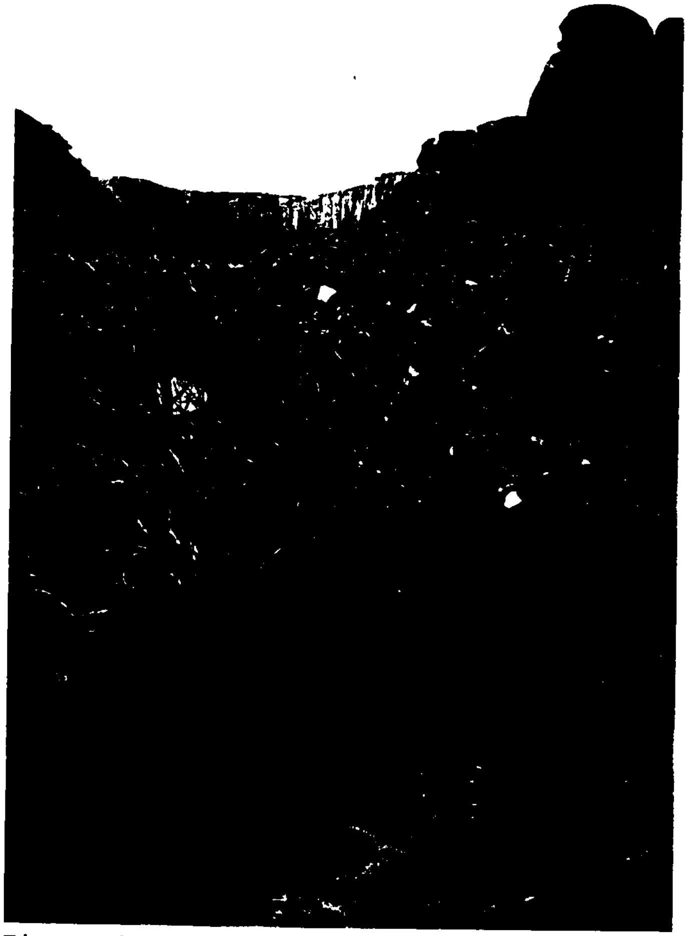

Figure 9. Northwest View of Brine Seepage Associated with Fault B at the South Abutment of the Brine Lake Dam.

Figure 10. North View of Brine Seepage Away From Fault B Below Brine Lake Dam.

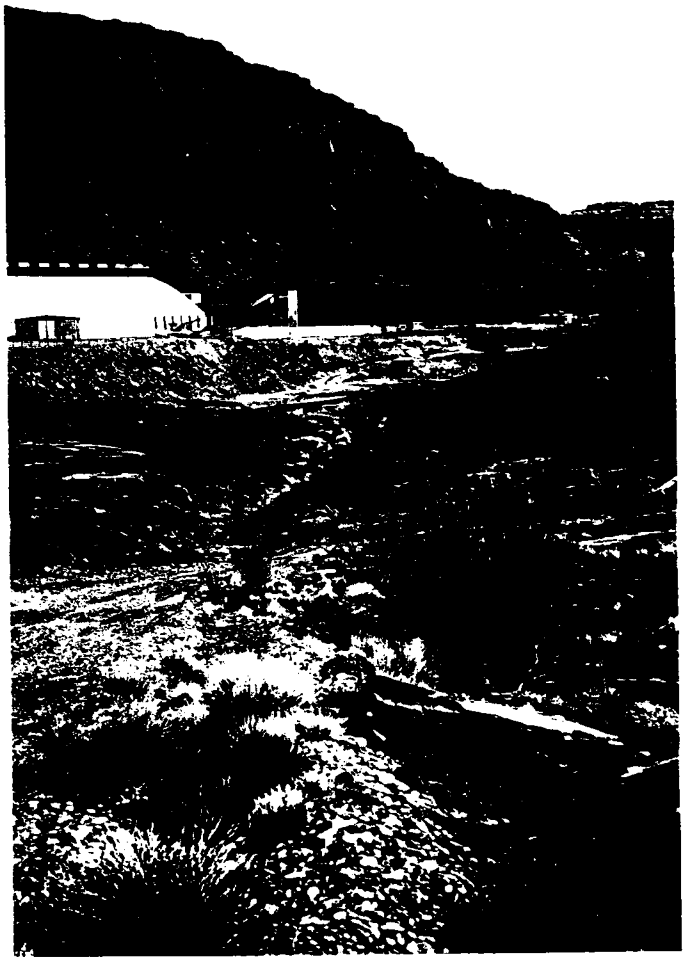

Figure 11. East View of Arroyo Below Brine Lake Dam.

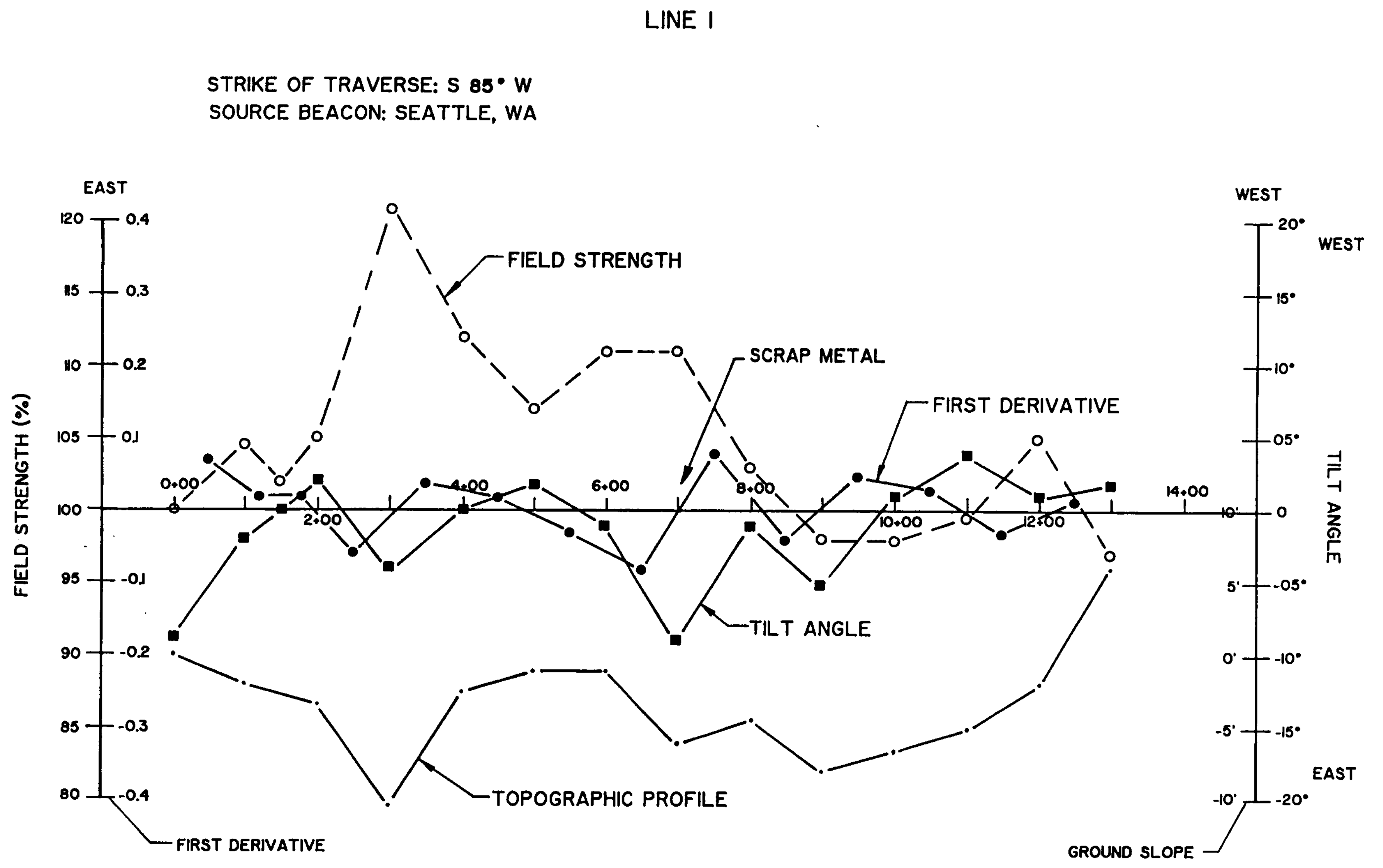

Figure 12. VLF-EM Profile of Line 1.

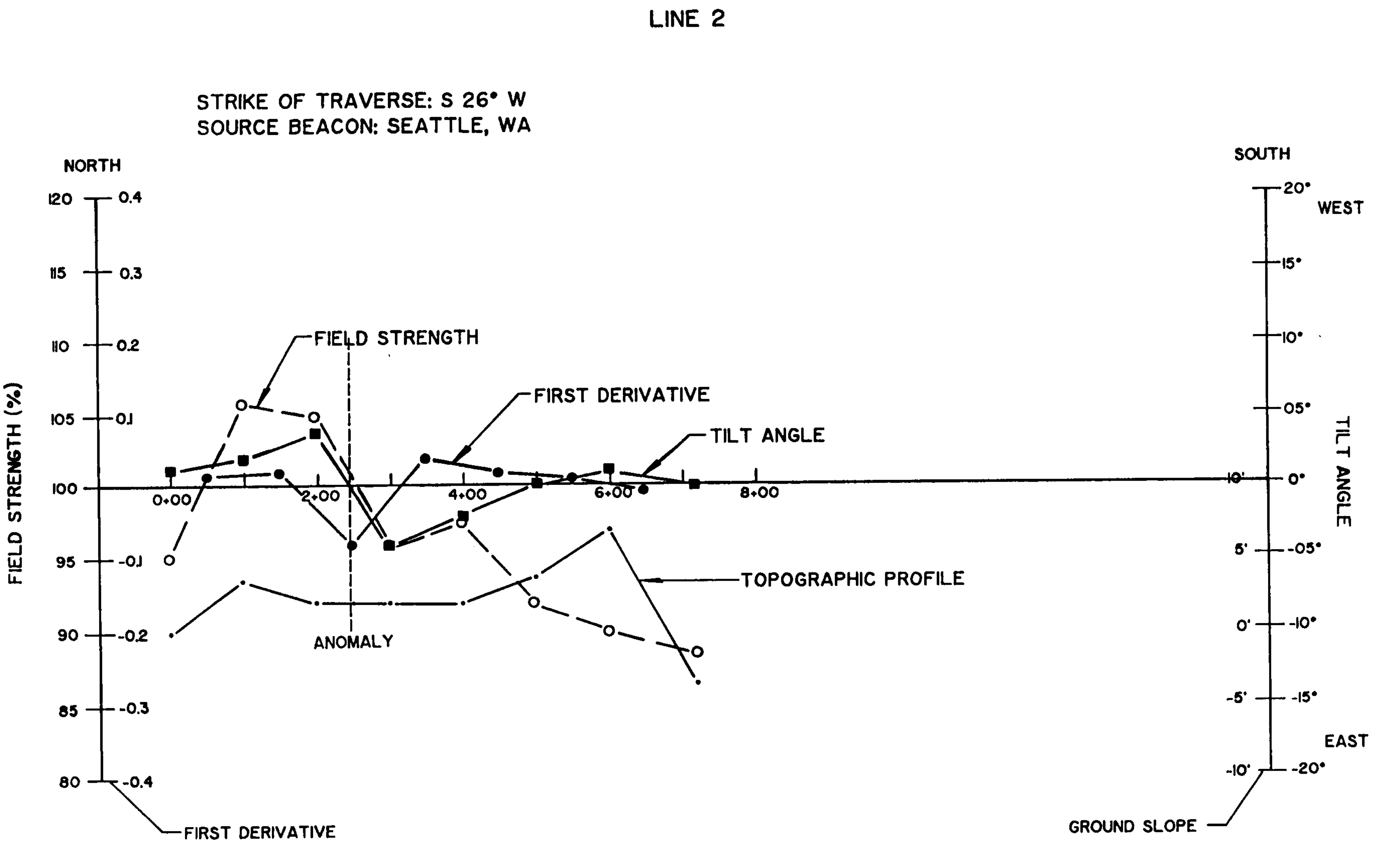

Figure 13. VLF-EM Profile of Line 2.

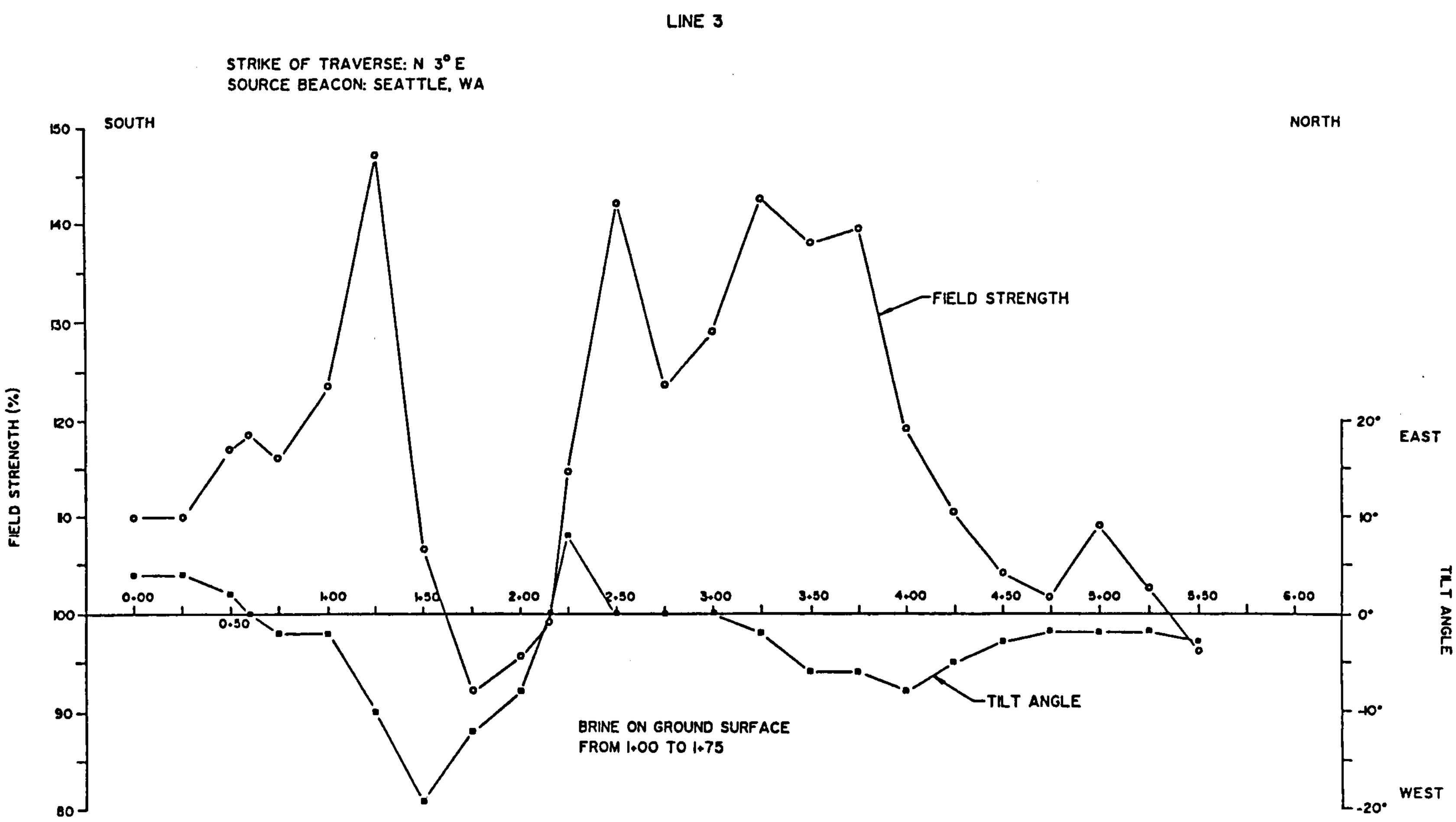

Figure 14. VLF-EM Profile of Line 3.

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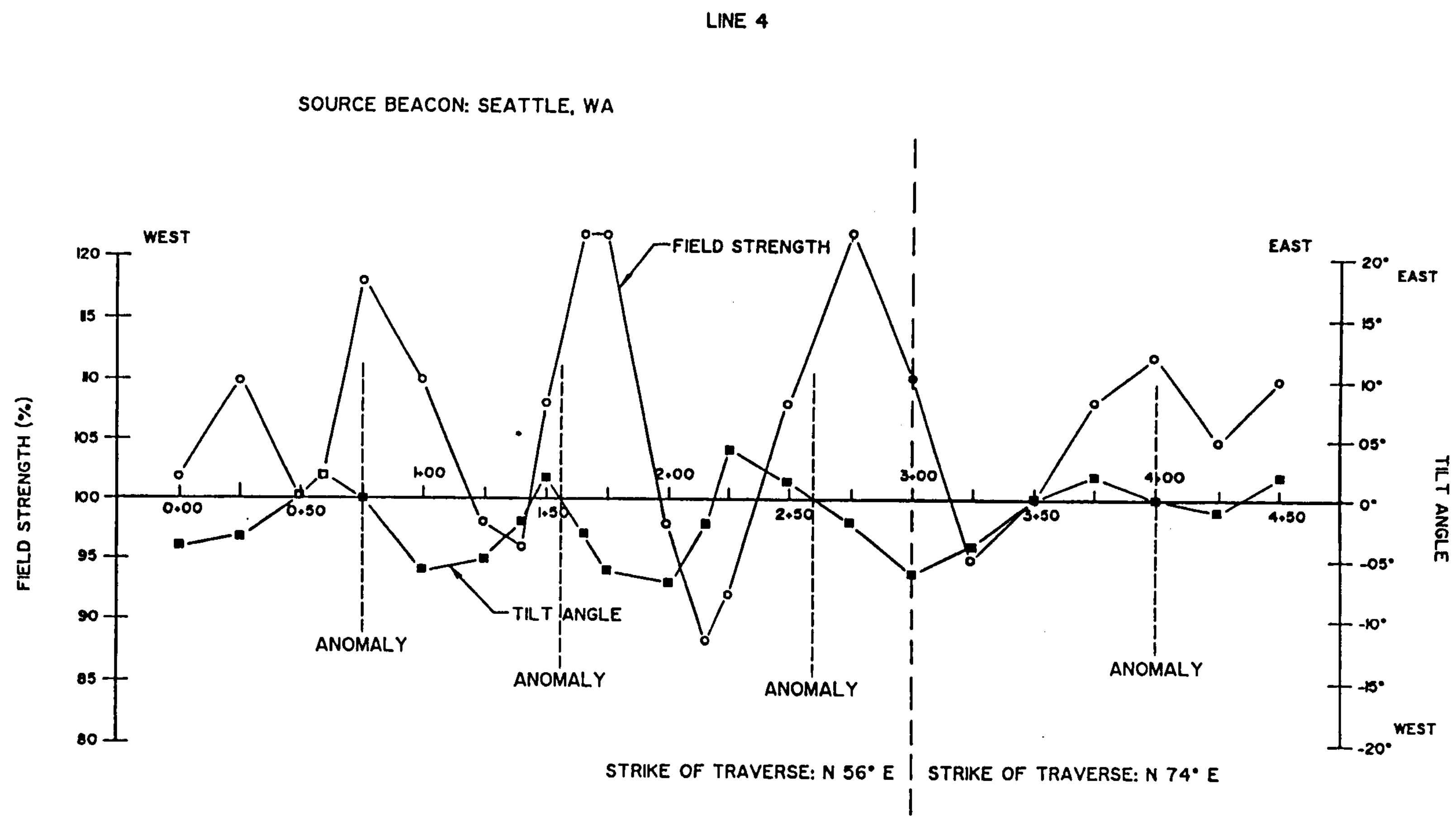

Figure 15. VLF-EM Profile of Line 4.

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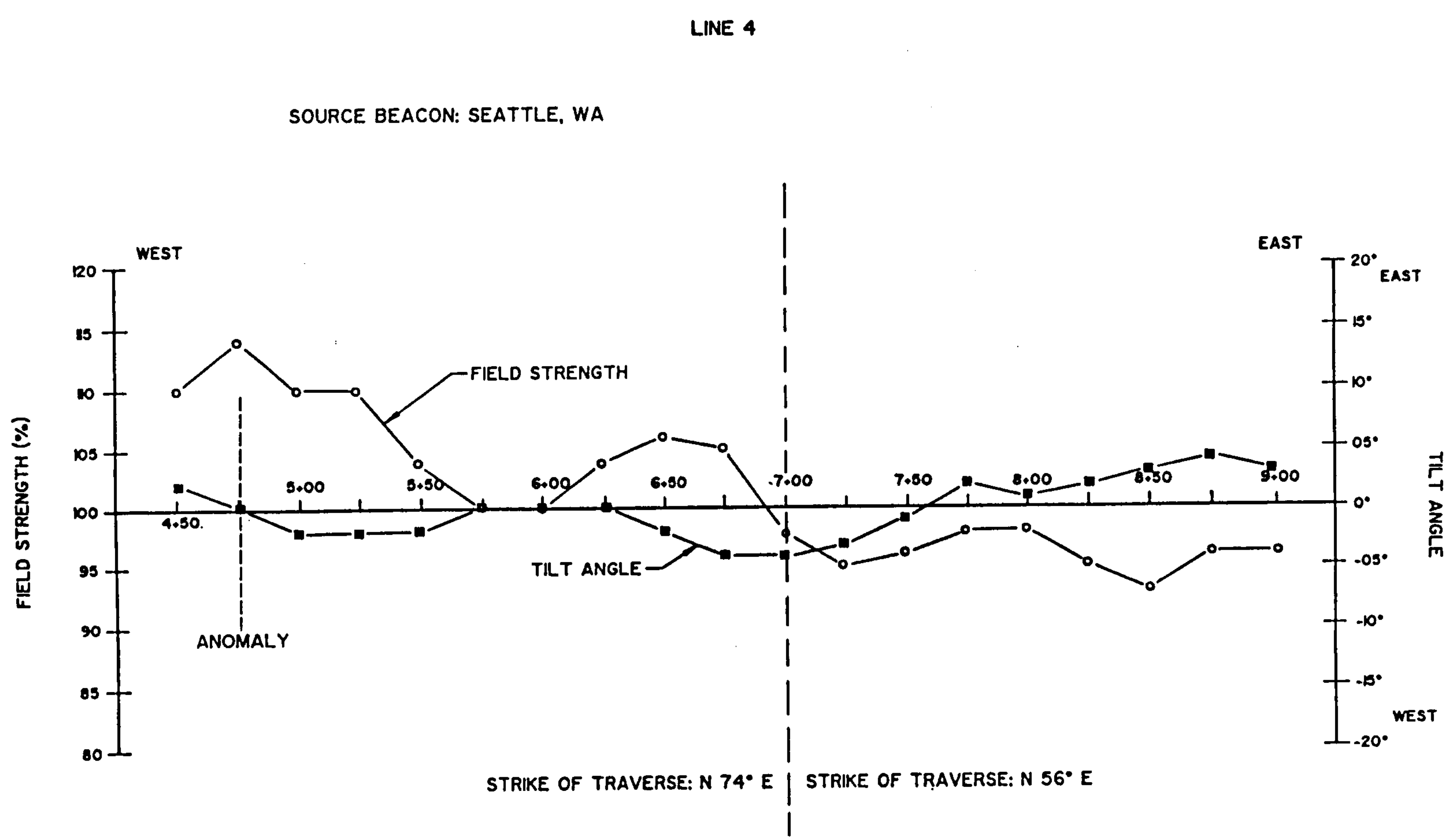

Figure 15. VLF-EM Profile of Line 4 (continued).

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Three "cross overs" or possible anomalies are shown along line 1 between stations 2+00 - 3+00, 6+00 - 7+00, and 8+00 - 9+00 (Figure 12). However, each possible anomaly shown by the tilt angle of the magnetic field closely mimics the topographic profile (vertical exaggeration 10x) shown in Figure 12, and thus are not considered indicative of conductors. The eastward tilt of the magnetic field at stations 0+00 and 1+00 probably is due to steel piping which lies east of those stations (the field strength was adjusted to 100 percent at station 0+00 and served as the base station; thus, anomalous field strengths were "zeroed-out" at station 0+00).

VLF line 2 runs southward from station 10+00 on line 1 (Figures 4 and 12). One probable anomaly is present on line 2 between stations 2+00 and 3+00 as shown in Figure 13. Note that the topographic profile is nearly level and the first derivative profile of the tilt angle is symmetrical and shows a change greater than 0.1 degree per foot. This anomaly may suggest brine seepage along fractures associated with fault D (Figure 4). Because rugged topography lies west of the line and conductive overburden (Tertiary and Quaternary terrace and stream deposits) lies east of the line, additional north-south lines were not surveyed.

VLF line 3 runs north-south along the toe of the brine lake spillway and the toe of the south abutment of the dam (Figures 4). Figure 14 shows profiles of field strength and tilt angle of the magnetic field along line 3, and Figure 10 shows the line of traverse toward the plant facility.

The anomaly shown between stations 0+50 and 0+75 on line 3 is coincident with a joint which intercepts the dam spillway. At the time of the survey, this joint was releasing small quantities brine to the ground surface. Fractures associated with fault B (Figure 4) are nearly coincident with station 1+00. Magnetic field strengths are accentuated at stations 1+00 through 1+50 and 2+25 through 4+00, although no sharp "cross overs" were recorded. Brine was present along the ground surface between stations 1+00 and 1+50 (see Figure 10), and probably was just below the ground surface between stations 2+25 and 4+00, thus the magnetic profile shown in these areas may be reflective of one or two diffuse anomalies unlike what would be expected if brine was confined to rock fractures only.

Figure 15 illustrates field strengths and tilt angles along VLF line 4, which runs eastward along the arroyo below the dam (see Figures 4 and 11). Station 0+00 of line 4 is coincident with station 5+25 of line 3.

Five anomalies are present along line 4 at stations 0+75, 4+00, 4+75, and between stations 1+50 - 1+75, and 2+50 - 2+75. Each of these anomalies is associated with fractured sandstone in the arroyo. Brine was not present on the ground surface at the time of the survey; nor was there evidence of past brine evaporation at the ground surface along the traverse.

Rock fractures associated with the first three anomalies along line 4 (stations 0+75, 1+50 - 1+75, and 2+50 - 2+75) intercept the north abutment of the brine lake dam. The westernmost of the three anomalies is nearly coincident with fault A which underlies the first catchment pond at the toe of the dam as shown in Figure 4. The last two anomalies along line 4 (stations 4+00 and 4+75) are not as accentuated in terms of field strength or changes in tilt angle as are the three anomalies to the west. Rock fractures associated with the latter anomalies intercept the area of the second catchment pond below the dam. It is probable that the rock fractures associated with the three western anomalies are receiving brine recharge from the area of the upper catchment pond, whereas fractures associated with the two easternmost anomalies may be receiving recharge from the area of the second catchment pond.

Because anomalies are absent along the last 400 feet of line 4, it is unlikely that rock fractures in this area are receiving brine recharge from the brine lake or catchment ponds below the toe of the dam. This suggests that brine seepage associated with the dam and spillway is controlled by the bedrock fractures and that the direction of brine seepage primarily is along the strike of the fractures, with little brine movement in the unfractured bedrock discordant with the strike of the fractures.

3.3 DISCUSSION

Geological and geophysical data presented in Sections 3.1 and 3.2 show the prevalence of brine seepage associated with the brine lake dam and spillway, and suggest that the brine seepage primarily is controlled by rock fractures in that area. These data also indicate that brine seepage along the arroyo below the dam probably is confined to the area of the two catchment ponds below the dam; thus, it is unlikely that significant amounts of brine are being transmitted along the entire length of the arroyo to the Colorado River.

Ground reconnaissance along terraces of the Colorado River southeast of mapped faults revealed no evidence of present or past brine seepage, with the exception of salt efflorescence near the southeastern termination of fault D and at the west end of VLF line 1. VLF data for the same general area suggest that brine seepage may be present near fault D. VLF data obtained along line 1 suggest that conductors are not present; however, shale units are present along portions of this traverse which may have effectively reduced the depth of penetration of the VLF method to less than 10 feet (Dick Fox of Practical Geophysics, personal communication).

Based on field observation of brine seepage along the northwest end of fault C and seepage along rock fractures near the dam, the conclusion is reached that the rock fractures have sufficient permeability to allow movement of significant amounts of brine. Even though conclusive evidence of brine movement is lacking for areas near the Colorado River, it is possible that these rock fractures form sufficient conduits for significant brine movement toward the river. Because of conductive overburden near the Colorado River and unsuitable topographic conditions between the river and the brine lake, VLF methods probably are not sufficient tools for reaching definite conclusions regarding downgradient migration along fractures toward the river from the brine lake area. Only test drilling of these fractures and subsequent monitoring of water/brine levels will allow suitable conclusions to be reached.

4.0 REFERENCES

Fraser, D.C. 1966. Contouring of VLF-EM Data: Geophysics, Vol. 34, pp. 958-967.

Huntoon, P.W. 1985. Geology and Ground Water Hydrology in the Vicinity of the Texasgulf Chemicals Company Potash Solution Mine, Grand and San juan Counties, Utah: Unpublished consulting report to Texasgulf Chemicals Company, Moab, Utah.

Paal, G. 1965. Ore Prospecting Based on VLF-Radio Signals: Geoexploration, Vol. 3, No. 3, pp. 139-148.

Paterson, N.R. and V. Ronka. 1971. Five Years of Surveying with the Very Low Frequency-Electro Magnetics Method: Geoexploration Vol. 9, No.1, pp. 7-26.

Phillips, W.J. and W.E. Richards. 1975. A Study of the Effectiveness of the VLF Method for the Location of Narrow-Mineralized Fault Zones: Geoexploration, Vol. 13, No. 4, pp. 215-226.

Whittles A.B.L. 1969. Prospecting with Radio Frequency EM-16 in Mountainous Regions: Western Miner, February 1969, pp. 51-56.

This page is a reference page used to track documents internally for the Division of Oil, Gas and Mining

Mine Permit Number M190005 Mine Name Cane Creek Potash
Operator Moab Salt LLC Date 12-17-1997
TO ______ FROM ______

__CONFIDENTIAL __BOND CLOSURE __LARGE MAPS X EXPANDABLE
__MULTIPUL DOCUMENT TRACKING SHEET __NEW APPROVED NOI
__AMENDMENT __OTHER______

Description YEAR-Record Number

__NOI ✓ Incoming __Outgoing __Internal __Superceded

Spill Prevention and Stormwater
Control Plan

__NOI __Incoming __Outgoing __Internal __Superceded

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__TEXT/ 81/2 X 11 MAP PAGES __11 X 17 MAPS __LARGE MAP

COMMENTS: ______

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